



Thermal Soaring Forecasting

Michael F. Stringfellow



Introduction

- Thermals
 - Columns of warm air that rise from the ground when heated by the sun
- Soaring
 - Sustained engineless flight using natural sources of lift



Definitions

- Boundary or mixing layer
 - The zone of the atmosphere near the ground where thermals occur
- Lapse Rate
 - Fall of air temperature with altitude
- Dew Point
 - Temperature at which moisture vapor in the air condenses
- Skew-T Chart
 - Fancy diagram used by meteorologists to plot lapse rate and relative humidity



Making Thermals

- Conditions for thermals
 - Sun heats the ground
 - Little cloud cover
 - Dry soil
 - Pools of warm air can form
 - Light winds or shelter
 - Thermal triggers
 - Mechanical disturbance (man-made or natural)
 - Hot air near the ground has buoyancy
 - Air above is lighter (cooler or drier)



Thermal Characteristics

- When triggered, hot air rises
- If surrounding air is lighter, thermal continues rising
- Thermal stops when it reaches temperature of surroundings
- Thermal strength depends on difference of temperature between it and surrounding air
 - Thermal Index



Thermal Forecasting

- Estimate solar heating of ground
 - Cloud cover
 - Time of year/day
- Estimate lapse rate and dew point of air
 - Actual and forecast soundings
 - Strength of thermals
 - Boundary layer depth (top of thermals)



Forecasting Tools

- National Weather Service
- NOAA
- Dr. Jack's Blipmaps
- Soaring forecasts

Forecasts from Soundings

Forecast high taken from TUS

7-APR-2005 12 UTC Soaring report from TUS upper air data.

Forecast high: 90 F; est. base of any clouds:16400 feet AGL.

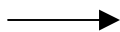
=== Raw Upper-Air Data ===

Feet MSL:	2585	3645	4946	10316	16811	18000	18243	18537	19082	20
Pres mb:	924	890	850	700	547	522	517	511	500	
Temp C:	19.4	21.8	20.0	8.8	-7.1	-10.5	-11.3	-11.7	-13.3	-1
VirT C:	19.8	22.2	20.4	9.1	-7.0	-10.1	-10.9	-11.4	-13.0	-1
DewPt C:	-7.6	-9.2	-10.0	-15.2	-33.1	-15.1	-15.2	-18.7	-19.3	-2
Wdir@kts:				135 16 225 10					230 22	

=== Interpolations (temps in deg. F, altitudes in feet MSL) ===

MSL	*TI*	Wdir@kts	trig	VirT	2.0 degrees/division ("": Dry Adiabatic)
18000	3.1			95 13.8	:
17500	2.9			95 16.1	:
17000	2.7			95 18.5	:
16500	2.5			94 20.7	:
16000	2.2	225	21	94 23.0	:
15500	2.0			94 25.2	:
15000	1.8	220	15	93 27.4	:
14500	1.5			93 29.7	:
14000	1.3	225	14	92 31.9	:
13500	1.0			92 34.1	:
13000	0.8			91 36.4	:
12500	0.5			91 38.6	:
12000	0.3	240	11	90 40.8	:
11500	0.0			90 43.1	:
11000	-0.2			90 45.3	:
10500	-0.4	225	10	90 47.5	:
10000	-0.8	220	11	89 49.6	:
9500	-1.2			89 51.4	:
9000	-1.7	215	10	88 53.3	:
8500	-2.1			87 55.2	:
8000	-2.5	195	9	86 57.1	:
7500	-3.0			86 59.0	:
7000	-3.4	165	8	85 60.9	:
6500	-3.8			84 62.8	:
6000	-4.3	140	12	83 64.7	:
5500	-4.7			82 66.6	:
5000	-5.1	135	16	82 68.5	:
4500	-5.9			80 69.8	:
4000	-6.7	130	21	79 71.0	:
3500	-8.0			77 71.3	:
3000	-10.6	125	18	72 69.3	:

-3 TI at
7,500 feet





How I Forecast Thermals

- Check actual and forecast weather
 - Weather Service, Webcams
- Check satellite maps
 - Visible, Infrared and water vapor
- Check Blipmaps
 - Thermal strength, top-of-the lift, buoyancy/shear ratio, cumulus prediction
- Check Forecast Soundings
 - Temperature, winds lapse rate, inversions, cloudbase, convective potential etc.

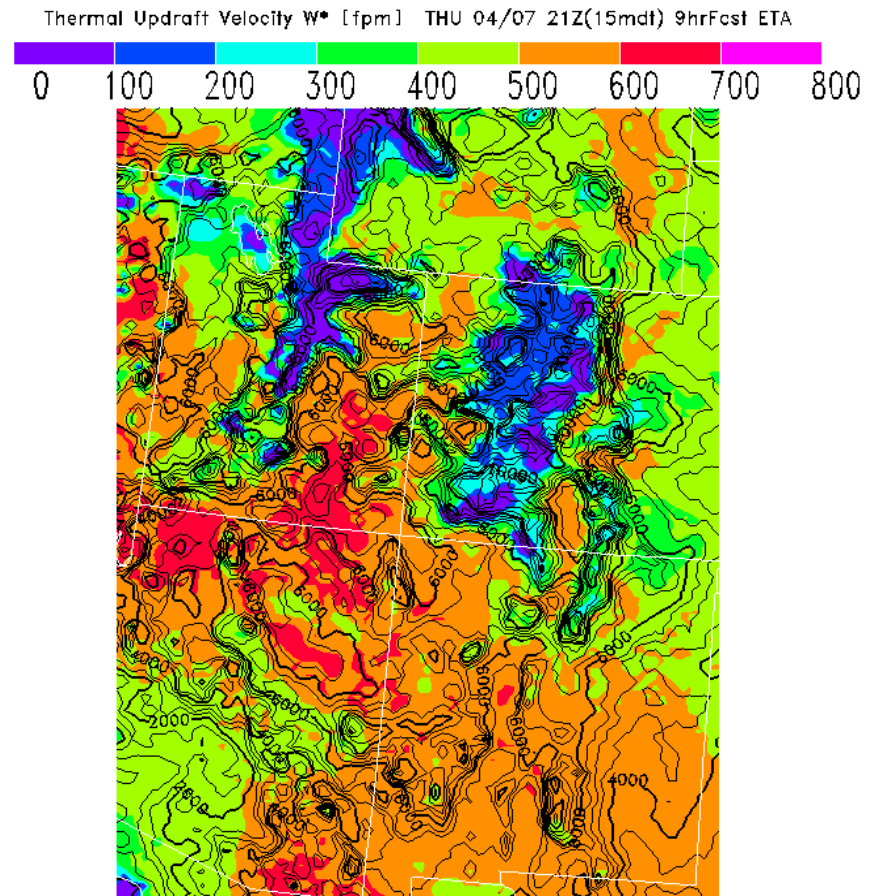


Soaring Forecast Page

- Seven main sub pages for forecasting:
 - Current Weather
 - Forecast Weather
 - Blipmaps & Blipspots
 - Mike the Strike's Forecast
 - Week's Soaring Forecast
 - Weather Links
 - Webcams

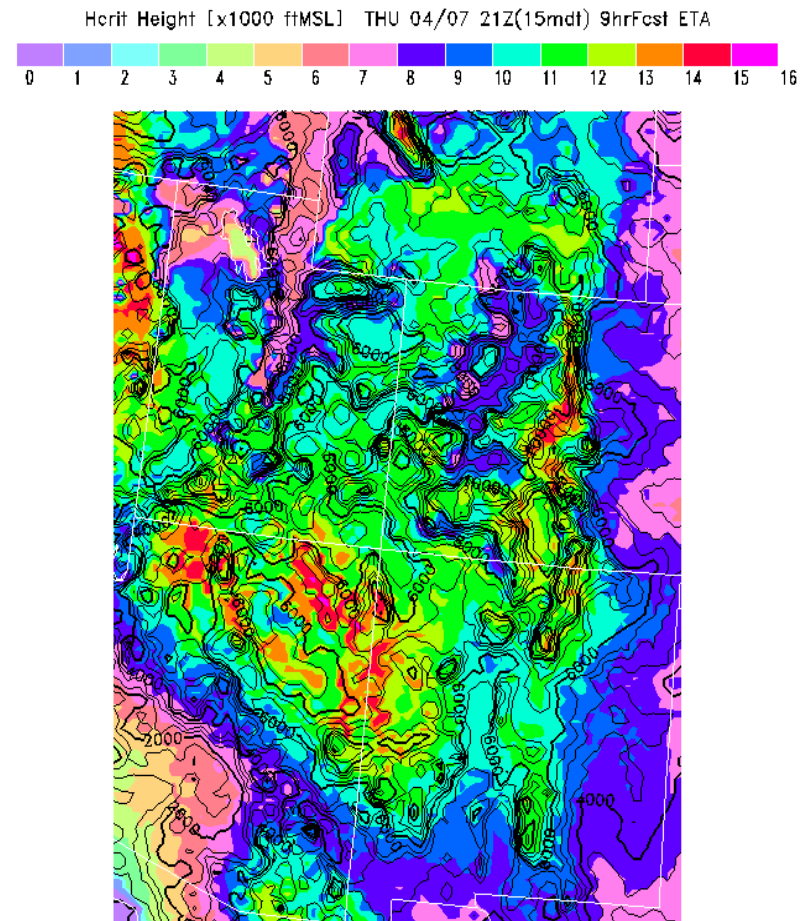
Reading Blipmaps - 1

- Thermal Strength
 - Predicted average net thermal strength
 - Subtract glider minimum sink rate to estimate actual rate of climb
 - Remember thermals will vary from weak to strong



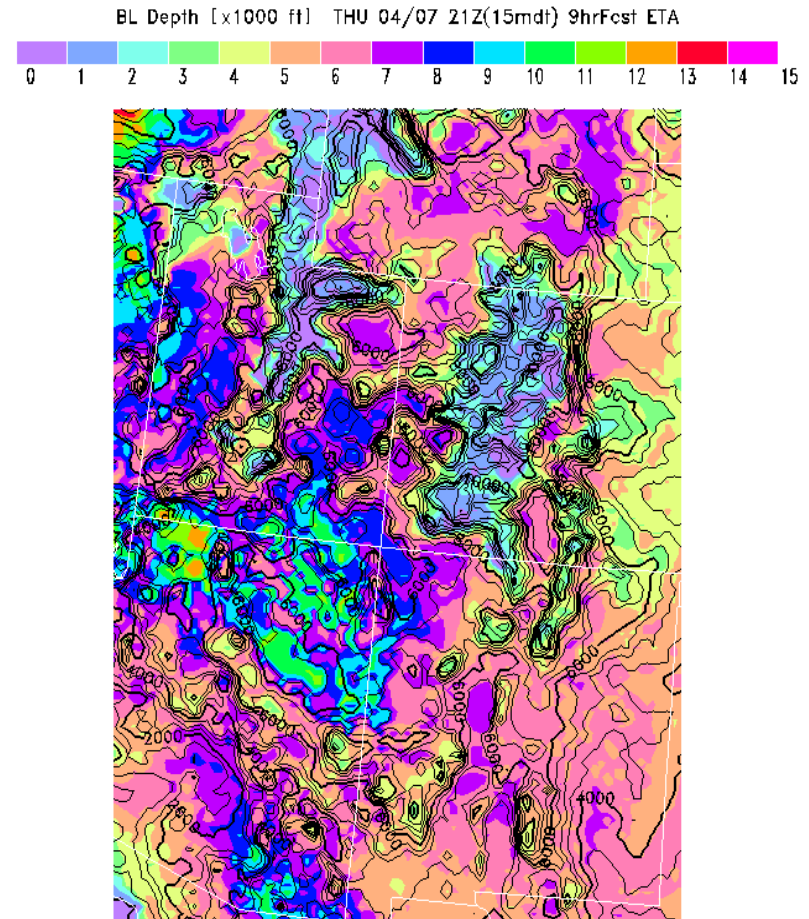
Reading Blipmaps - 2

- Top of the lift
 - Hcrit is top of the lift experienced by a glider in feet MSL
 - Usually at the -3 TI point on the Skew-T chart



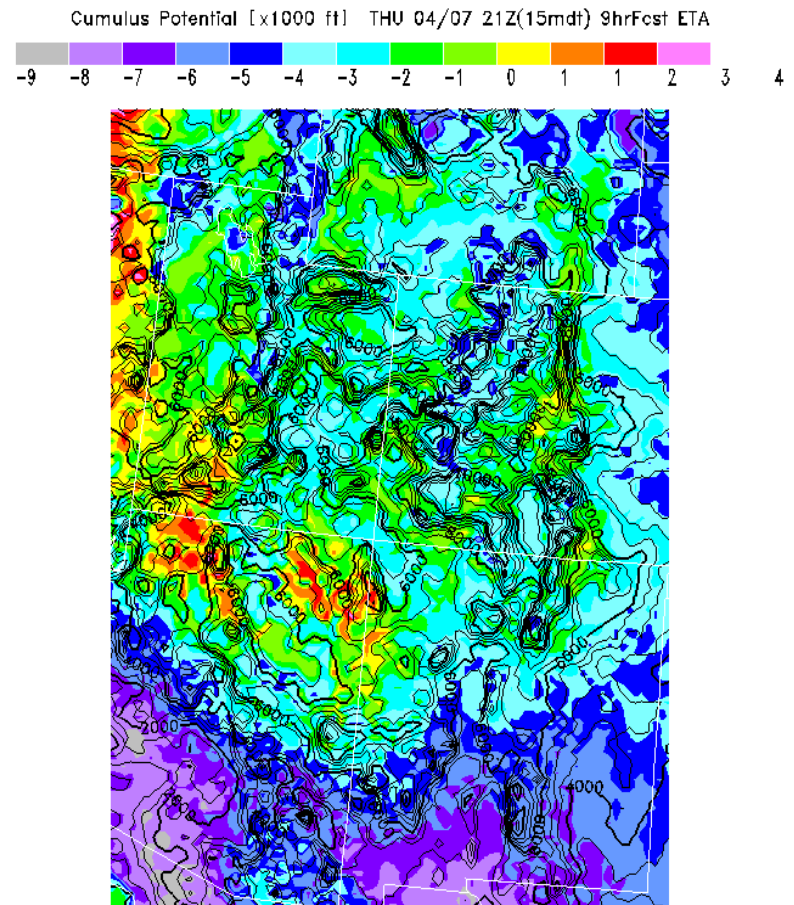
Reading Blipmaps - 3

- Boundary Layer Depth
 - Height of thermals above the ground in feet
 - Remember you won't usually get this high in a glider



Reading Blipmaps - 4

- Cumulus Potential
 - Chance of thermal-generated cumulus clouds

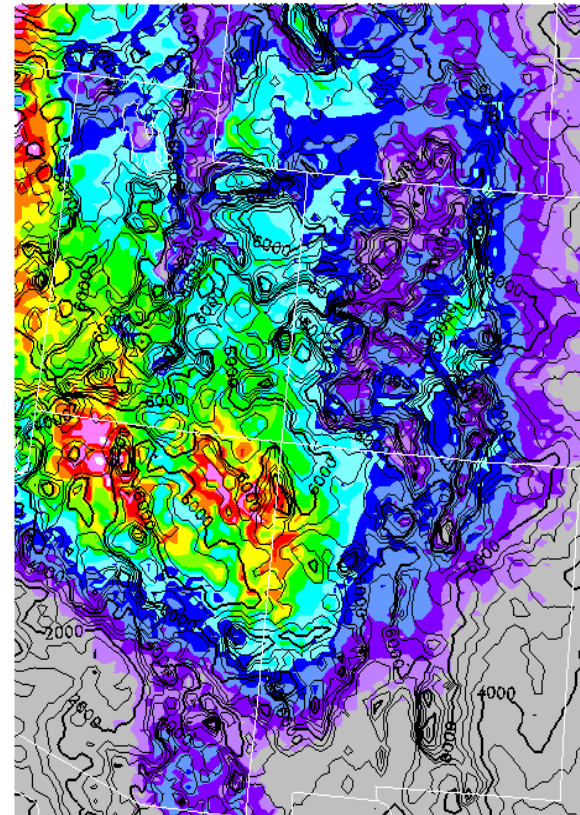


Reading Blipmaps - 5

- Overdevelopment Potential
 - Chance for showers and thunderstorms
 - Usually not good when too high!

OverDevelopment Potential [x1000 ft] THU 04/07 21Z(15mdt) 9hrFest ETA

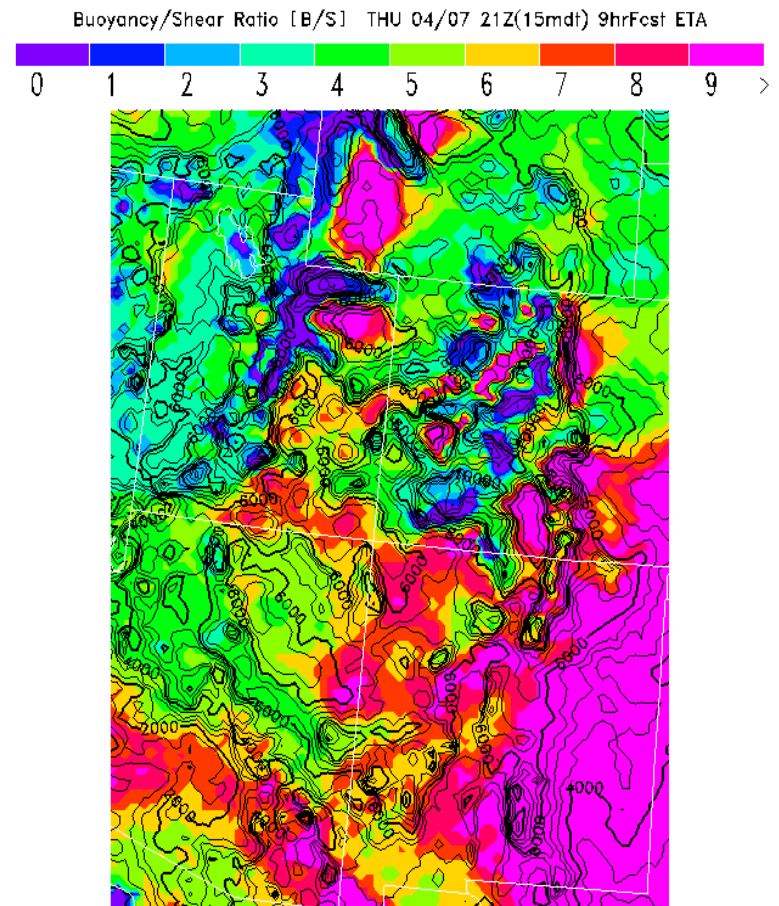
-10.1	-9.2	-8.3	-7.5	-6.7	-5.9	-5.0	-4.2	-3.4	-2.6	-1.7	-0.9	-0.1	0.7	2.
-------	------	------	------	------	------	------	------	------	------	------	------	------	-----	----



Reading Blipmaps - 6

■ Buoyancy/Shear Ratio

- Indicates chance of thermals blowing apart in wind
- Less likely with strong thermals or weak winds
- >5 is usually OK
- <5 thermals broken



Reading Blipspots

DrJack's BLIPSPOT for: THU 04/07 LakePleasant_AZ 1580ft pt24768@-112.197,33.735,1795ft

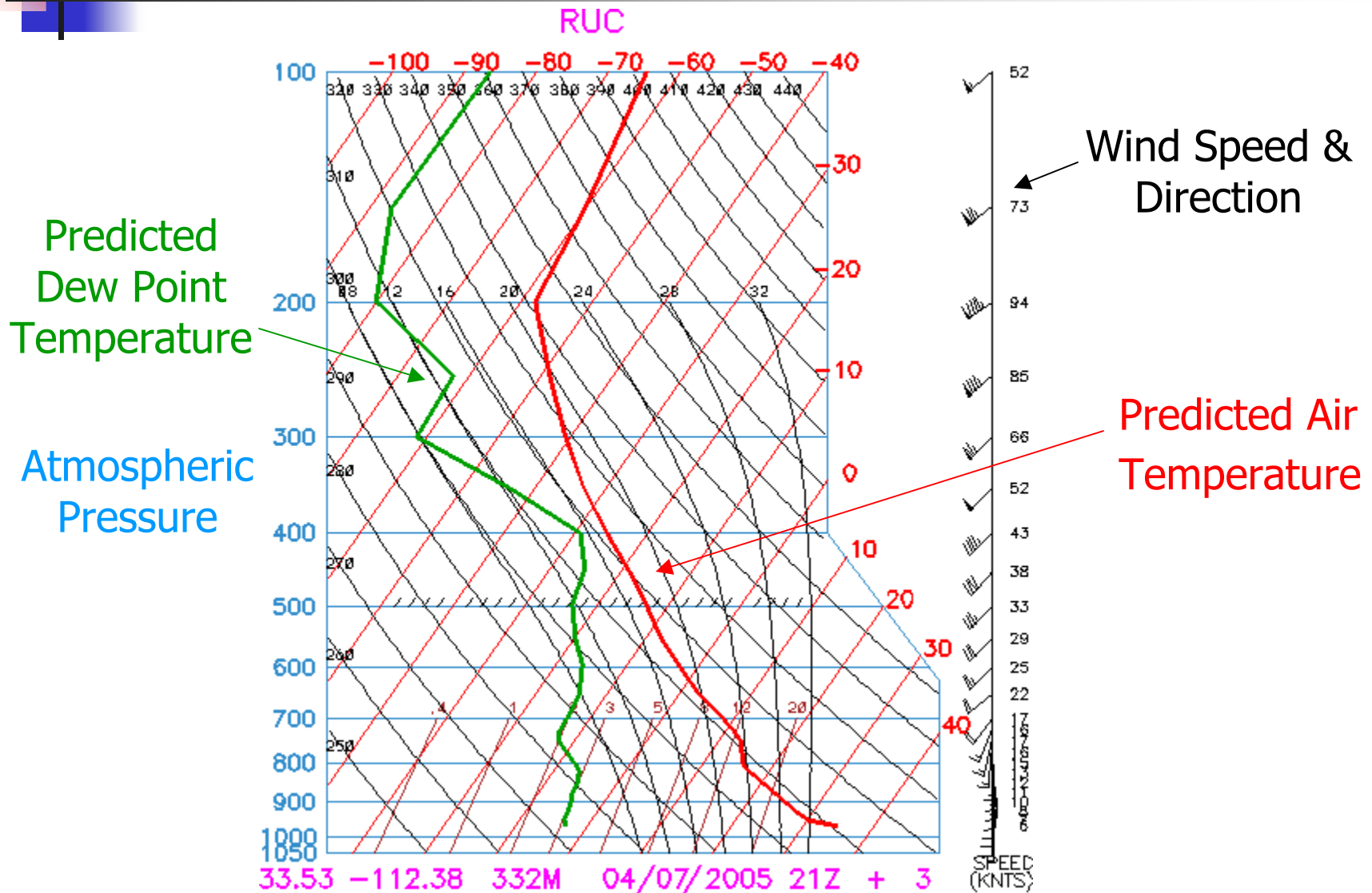
BLIPSPOT sfc.temp. adjusted by -0.7 degF
SPONSORED BY: Ted Grussing

RUC - Last Analysis, Validation Time = 18Z 3Z

Data for 2 PM Local

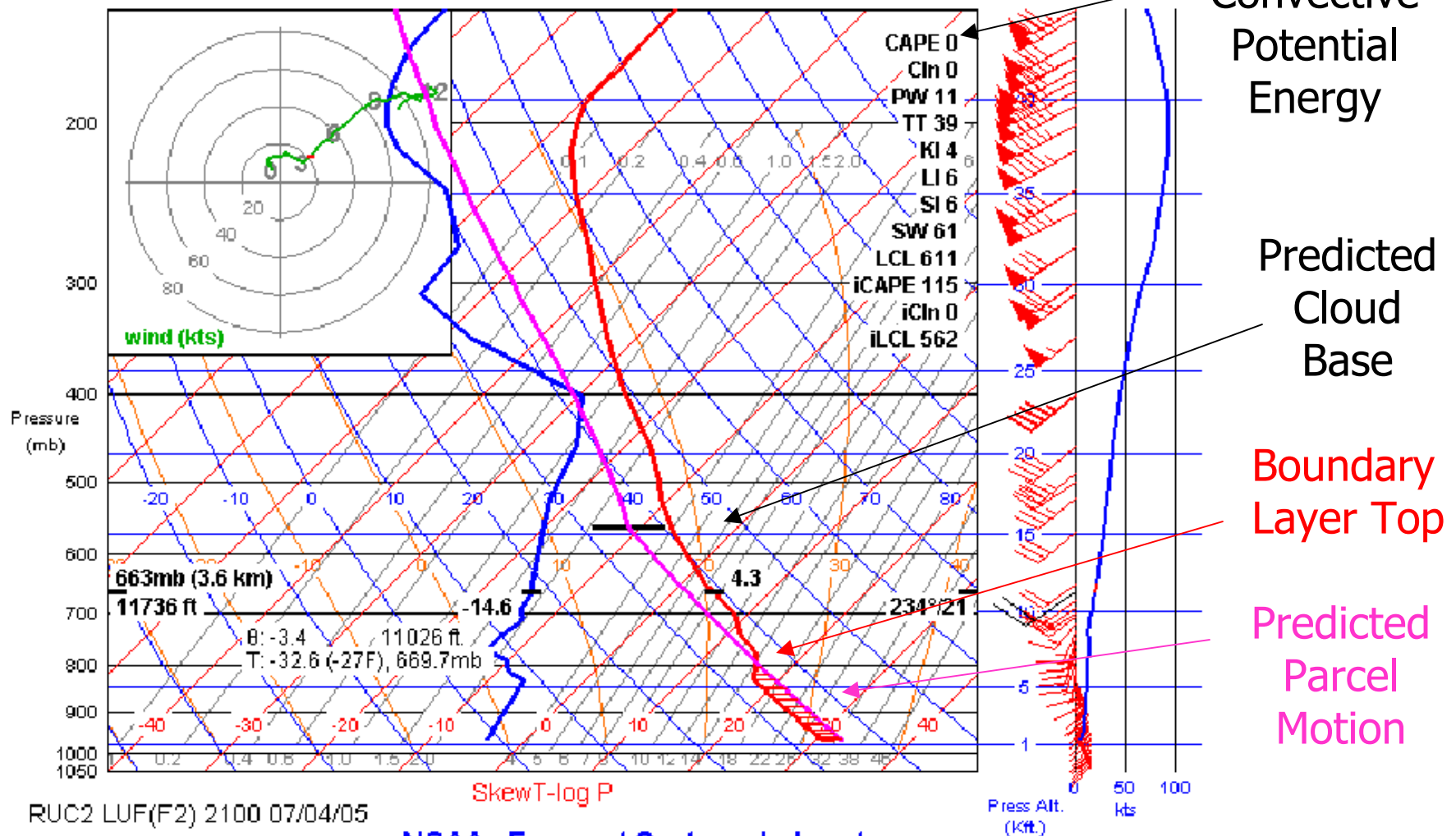
	VALIDATION TIME														
	15Z	16Z	17Z	18Z	19Z	20Z	21Z	22Z	23Z	0Z	1Z	2Z	3Z		
FCST PERIOD	6 hr	-	-	6 hr	-	-	6 hr	-	-	6 hr	-	-	9 hr	FCST PERIOD	
Temp@2m	67.7	-	-	83.6	-	-	91.3	-	-	88.4	-	-	79.4	Temp@2m	
Sfc.Heating	67	-	-	451	-	-	498	-	-	99	-	-	-27	Sfc.Heating	
BL Depth	215	-	-	4128	-	-	6265	-	-	5081	-	-	215	BL Depth	
Hcrit	1580	-	-	4488	-	-	6226	-	-	4396	-	-	1580	Hcrit	
BL Top	1795	-	-	5708	-	-	7845	-	-	6661	-	-	1795	BL Top	
Hgt.Variab.	1482	-	-	1999	-	-	3442	-	-	1827	-	-	927	Hgt.Variab.	
W*	99	-	-	501	-	-	596	-	-	324	-	-	0	W*	
B/S	2	-	-	6	-	-	8	-	-	4	-	-	0	B/S	
BL Wind	9	-	-	14	-	-	14	-	-	13	-	-	6	BL Wind	
Direction	101	-	-	143	-	-	174	-	-	220	-	-	269	Direction	
Wind Shear	0	-	-	5	-	-	10	-	-	9	-	-	0	Wind Shear	
Max.Converg	-4	-	-	14	-	-	-11	-	-	13	-	-	2	Max.Converg	
CLOUDpotent	-9510	-	-	-9907	-	-	-9092	-	-	-9636	-	-	-12505	CLOUDpotent1	
sfcLCL	11305	-	-	15615	-	-	16938	-	-	16298	-	-	14301	sfcLCL	
ODpotential	-15690	-	-	-13421	-	-	-11082	-	-	-11578	-	-	-15234	ODpotential	
blCL	17485	-	-	19129	-	-	18927	-	-	18239	-	-	17029	blCL	
maxRH	41	-	-	27	-	-	80	-	-	91	-	-	101	maxRH	
Temp@2m	67.7	-	-	83.6	-	-	91.3	-	-	88.4	-	-	79.4	Temp@2m	
DewPt@2m	26.8	-	-	22.1	-	-	23.4	-	-	24.1	-	-	25.1	DewPt@2m	
Temp@Bot	67.3	-	-	81.0	-	-	88.5	-	-	87.7	-	-	79.6	Temp@Bot	
DewPt@Bot	26.8	-	-	22.1	-	-	23.4	-	-	24.0	-	-	25.1	DewPt@bot	
Sfc.Heating	67	-	-	451	-	-	498	-	-	99	-	-	-27	Sfc.Heating	
BL Depth	215	-	-	4128	-	-	6265	-	-	5081	-	-	215	BL Depth	

Reading Skew-T Charts



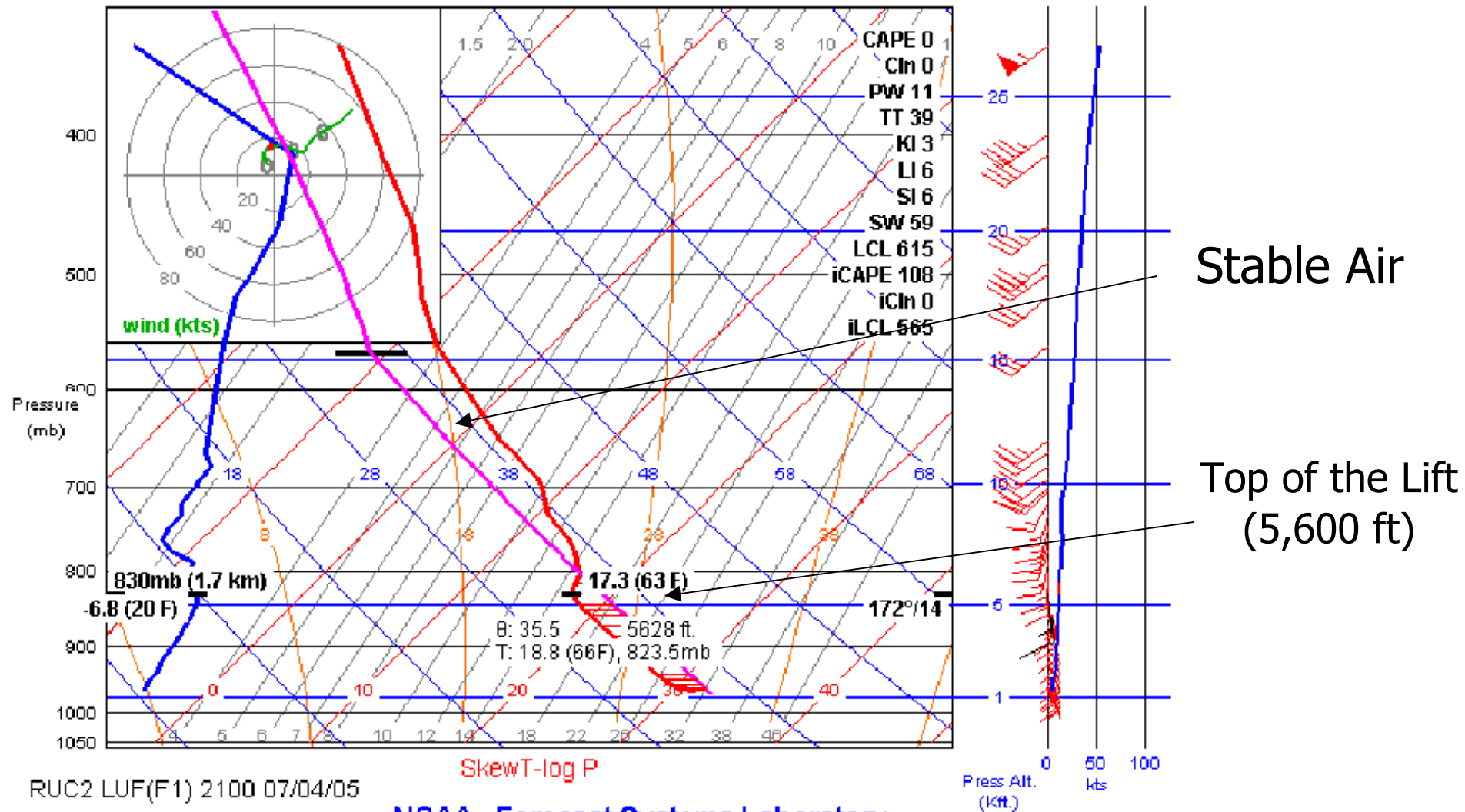
Interactive Skew-T (Arizona)

RUC2 2h Forecast, 07-Apr-2005 21:00:00 (10.6nm/174° from LUF)



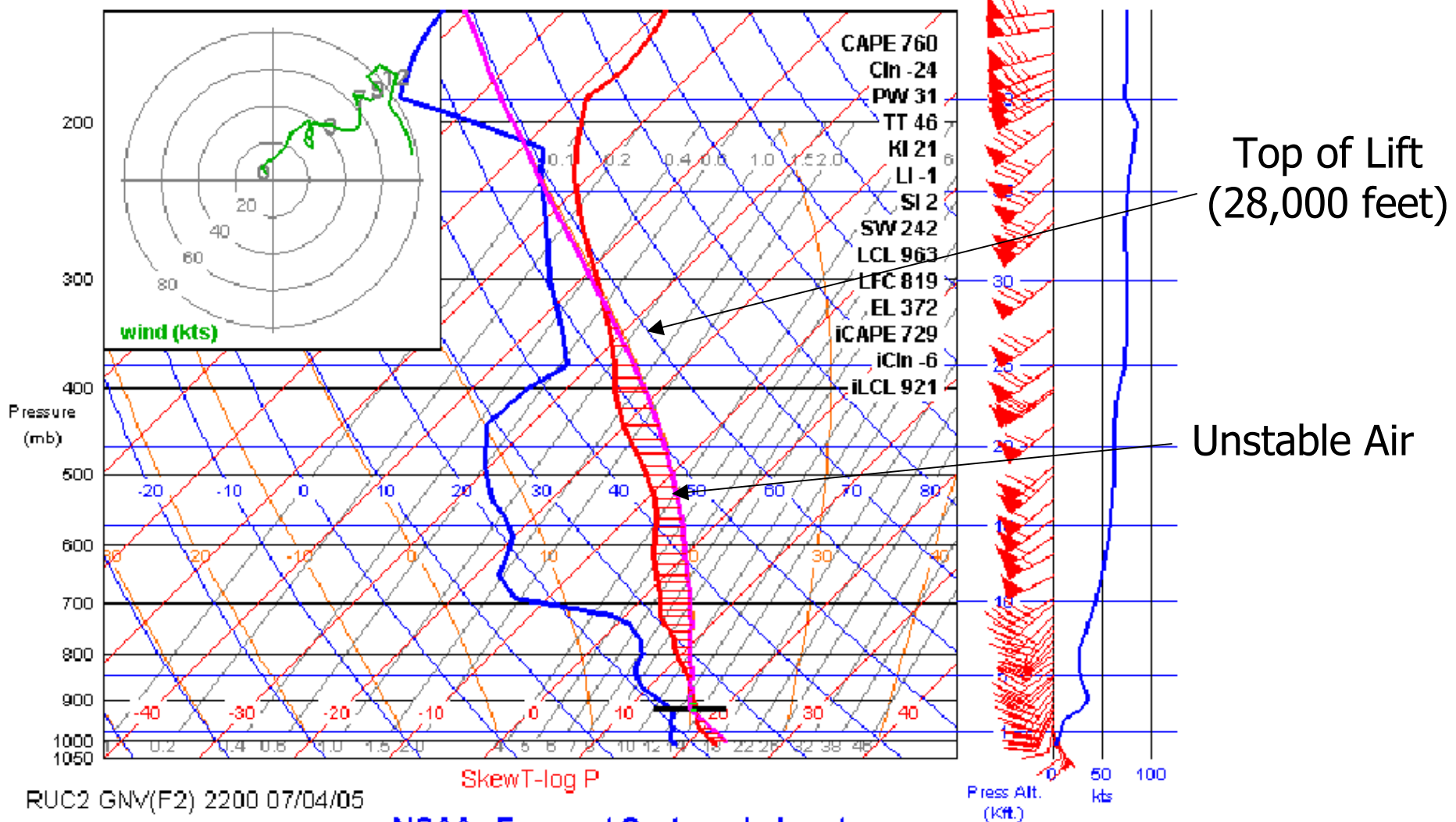
Interactive Skew-T (Arizona)

RUC2 1h Forecast, 07-Apr-2005 21:00:00 (10.6nm/174° from LUF)



Interactive Skew-T (Florida)

RUC2 2h Forecast, 07-Apr-2005 22:00:00 (9.1nm/314° from GNV)



NOAA's Ready Forecast Tools



HOME HYSPLIT DISPERSION MODELING METEOROLOGY EMERGENCY RESPONSE STATUS

CURRENT METEOROLOGY (WORLD)

Forecast Model Graphics

Choose a forecast location by entering an [4-character ICAO station identifier](#) or a [6-digit WMO index number](#) or a latitude/longitude pair and then click the Continue button, or by clicking on the location in the map. You will be taken to the model products section.

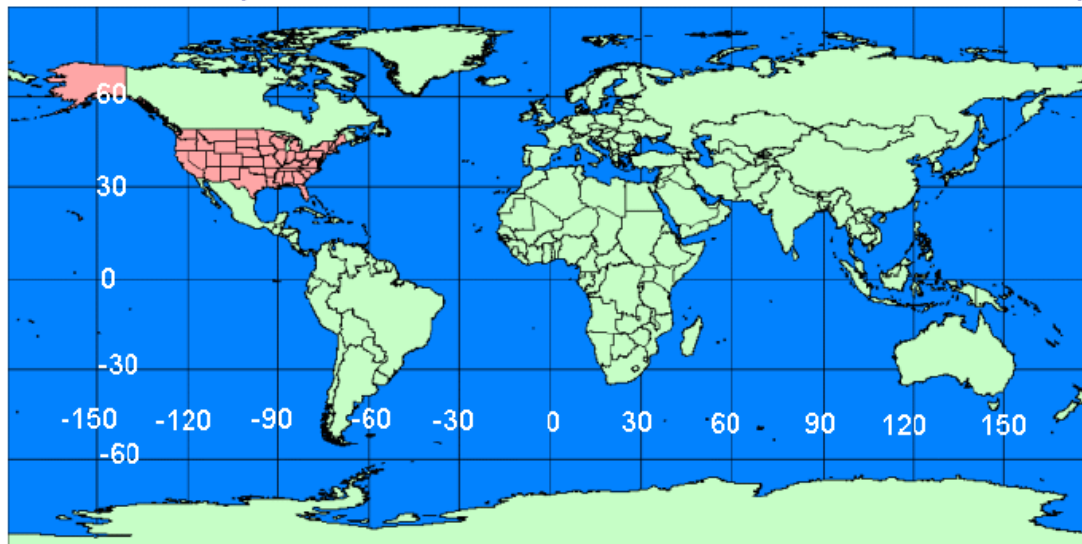
ICAO or WMO ID: [Search for Code](#) OR Latitude (degrees)
Or choose a city --> Longitude (West < 0)

OR click a location on the map below.

North American Map

United States

Global Map



NOAA Ready Menu



[HOME](#) [HYSPLIT](#) [DISPERSION MODELING](#) [METEOROLOGY](#) [EMERGENCY RESPONSE](#) [STATISTICS](#)

Return to: [CURRENT METEOROLOGY](#) | [STATE WEATHER](#)

READY PRODUCTS FOR LOCATION:

LUKE_AFB/PHOENIX, AZ US
(Lat: 33.53 Lon: -112.38 elevation: 332 m)

DISPLAY PROGRAM What is UTC, GMT, Z time?	METEOROLOGICAL DATA Model Data Status Information on forecast datasets	
AUTOGRAM	----- Plot up to 6 meteograms at a time -----	
METEOGRAM	-----Choose A Forecast Dataset-----	<input type="button" value="Go"/>
WINDGRAM	-----Choose A Forecast Dataset-----	<input type="button" value="Go"/>
WINDROSE	-----Choose A Forecast Dataset-----	<input type="button" value="Go"/>
SOUNDING	-----Choose A Forecast Dataset-----	<input type="button" value="Go"/>
STABILITY TIME-SERIES	-----Choose A Forecast Dataset-----	<input type="button" value="Go"/>
INTERACTIVE MAP	-----Choose A Forecast Dataset-----	<input type="button" value="Go"/>
INTERACTIVE MAP (JAVA-BASED)	-----Choose A Forecast Dataset-----	<input type="button" value="Go"/>
DATASET HELP	-----Choose A Forecast Dataset-----	<input type="button" value="Go"/>
FORECAST MODEL ANIMATIONS		

READY RUC Sounding Menu



[HOME](#) [HYSPLIT](#) [DISPERSION MODELING](#) [METEOROLOGY](#) [EMERGENCY RESPONSE](#) [STATUS](#)

RUC Sounding

Time to plot (start time for animation):		April 07, 2005 at 21 UTC (+ 03 Hrs) ▼																																																																																																												
Animation:	<input checked="" type="radio"/> None	<input type="radio"/> GIF	<input type="radio"/> Java	<input type="radio"/> Javascript	Duration: 12 ▼ hours																																																																																																									
Type:	<input checked="" type="radio"/> Full Sounding <input type="radio"/> Only to 400 mb																																																																																																													
Output:	<input checked="" type="radio"/> Graphic and text <input type="radio"/> Text only																																																																																																													
Graphics:	<input checked="" type="checkbox"/> Skew-T Log-P	<input type="checkbox"/> Theta	<input type="checkbox"/> Text Listing																																																																																																											
Graphic size (pixels):		<input type="radio"/> 400	<input type="radio"/> 500	<input checked="" type="radio"/> 700	<input type="radio"/> 900 <input type="radio"/> 1200																																																																																																									
<p>Type your access code (displayed at right) into the text box. This code is an image that cannot be read by a computer. This access code prevents automated programs from requesting access to READY products, which have saturated the system denying others from obtaining products in a timely manner.</p> <p>READY Use Agreement</p>		<p>Your access code is:</p> <p>Enter the access code from the box above to request product (case insensitive):</p> <table border="1"><tr><td>M</td><td>Q</td><td>V</td><td>Y</td><td>N</td><td>W</td><td>Y</td><td>T</td><td>Y</td><td>E</td><td>C</td><td>A</td><td>Z</td><td>W</td><td>C</td></tr><tr><td>W</td><td>P</td><td>F</td><td>T</td><td>Z</td><td>X</td><td>V</td><td>F</td><td>A</td><td>Q</td><td>E</td><td>Z</td><td>P</td><td>R</td><td>P</td></tr><tr><td>G</td><td>Y</td><td>C</td><td>V</td><td>K</td><td>S</td><td>M</td><td>D</td><td>Y</td><td>S</td><td>O</td><td>I</td><td>L</td><td>B</td><td>F</td></tr><tr><td>T</td><td>N</td><td>I</td><td>S</td><td>D</td><td>F</td><td>V</td><td>D</td><td>K</td><td>U</td><td>V</td><td>X</td><td>U</td><td></td><td></td></tr><tr><td>K</td><td>H</td><td>A</td><td>T</td><td>E</td><td>K</td><td>E</td><td>W</td><td>X</td><td>U</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>H</td><td>Q</td><td>W</td><td>N</td><td>A</td><td>S</td><td>O</td><td>Z</td><td>C</td><td>E</td><td>F</td><td>O</td><td>N</td><td>P</td><td>D</td></tr><tr><td>D</td><td>J</td><td>X</td><td>M</td><td>Q</td><td>F</td><td>F</td><td>E</td><td>P</td><td>G</td><td>K</td><td>Q</td><td>I</td><td>X</td><td>E</td></tr></table> <p><input type="text" value="isdfvd"/> <input type="button" value="Get Profile"/> <input type="button" value="Reset"/></p>				M	Q	V	Y	N	W	Y	T	Y	E	C	A	Z	W	C	W	P	F	T	Z	X	V	F	A	Q	E	Z	P	R	P	G	Y	C	V	K	S	M	D	Y	S	O	I	L	B	F	T	N	I	S	D	F	V	D	K	U	V	X	U			K	H	A	T	E	K	E	W	X	U						H	Q	W	N	A	S	O	Z	C	E	F	O	N	P	D	D	J	X	M	Q	F	F	E	P	G	K	Q	I	X	E
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READY RUC Sounding Result



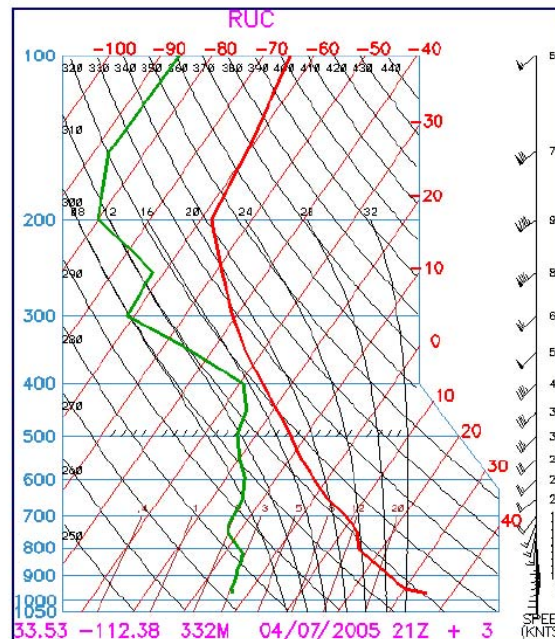
HOME HYSPLIT DISPERSION MODELING METEOROLOGY EMERGENCY RESPONSE STATUS

RUC Sounding for location: LUF

LUKE_AFB/PHOENIX, AZ, US
(Lat: 33.53 Lon: -112.38 elevation: 332 m)

[Another profile](#) [Another product](#) [Another location](#) [Start over](#)

Skew-T LogP Diagram



Sounding text and any error messages.
Time-series text results

Ready Interactive Map Menu



HOME HYSPLIT DISPERSION MODELING METEOROLOGY EMERGENCY RESPONSE STATUS C

ARL PLOT - Meteorological Mapping

This program plots GFS meteorological data on a map.

Choose a date/time: April 07, 2005 at 12 UTC (+ 00 Hrs) ▼

Overlay two fields? ☐ No Overlay ☒ Overlay

	Meteorological Field(s) (SFC = surface field; 3D = above surface field)	Level	Contour	
			type	interval
1	Mixed Layer Height (SFC) ▼	SFC ▼	Color Filled ▼	100
2	Total Cloud Cover (SFC) ▼	SFC ▼	Color Lines ▼	0.0

Note: choosing a contour interval (X) for Wind Vectors causes only every X vector to be plotted.

Graphic Size (pixels) ☐ 400 ☐ 500 ☒ 700 ☐ 900 ☐ 1200

Map Domain ☐ Full Grid ☒ Subgrid

Center Latitude (degrees)	Center Longitude (West is negative)	Map Radius (degrees)
33.53	-112.38	2.2

Type your access code (displayed at right) into the text box. This code is an image that cannot be read by a computer. This access code prevents automated programs from requesting access to READY products, which have saturated the system denying others from obtaining products in a timely manner.

[READY Use Agreement](#)

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GQPKBGLXBGXDJOB
OLJLLNNEFVENQ
AATLGEHRHZZU
BXYZVPNSLVUSGYV
DUVKOTMUZKNKZGR

Enter the access code from the box above to request product (case insensitive):

XQBUTG

Get Map

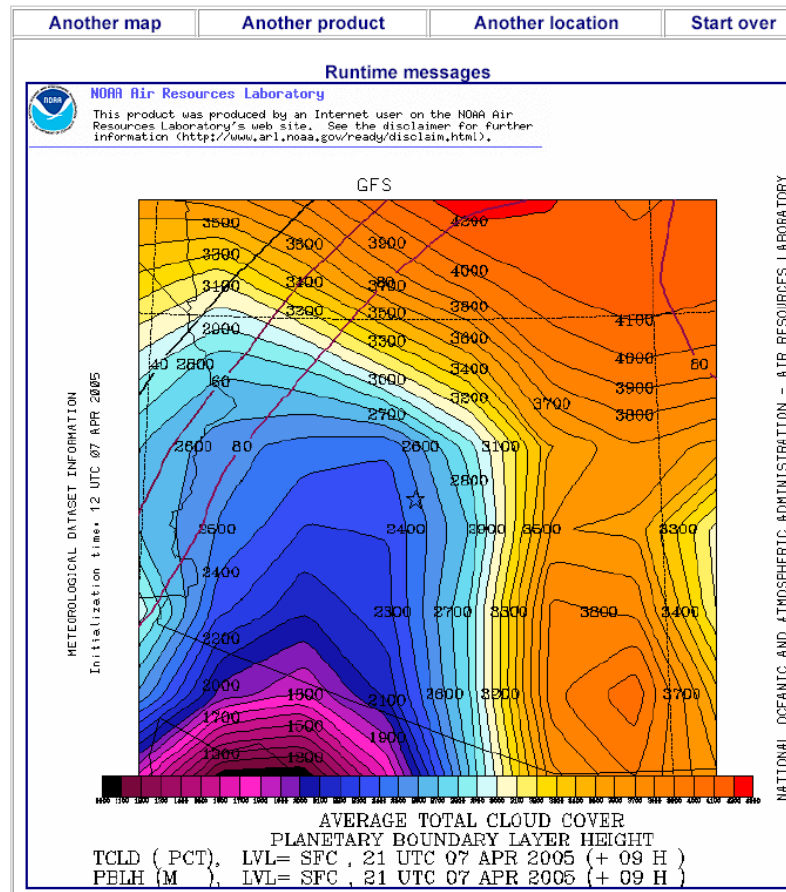
Reset

Resulting Map of Arizona



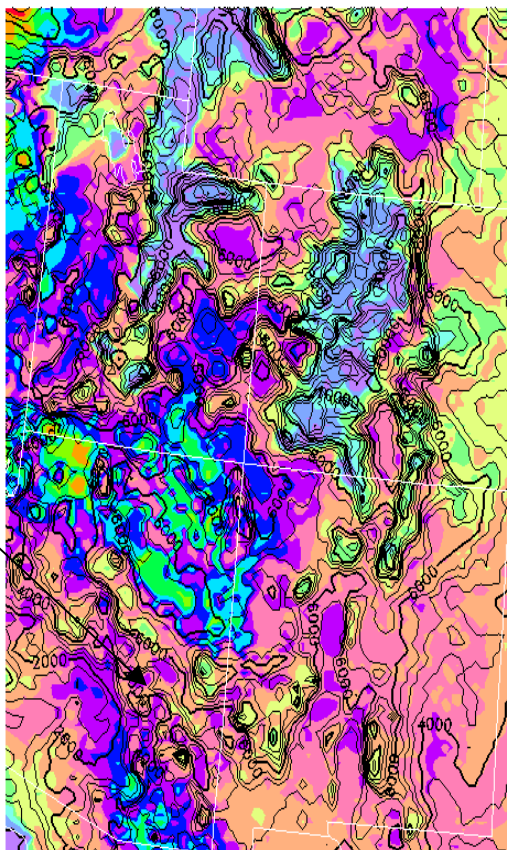
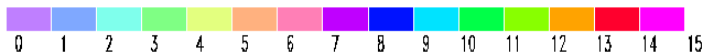
HOME HYSPLIT DISPERSION MODELING METEOROLOGY EMERGENCY RESPONSE STATUS

Map centered over: LUF



Boundary Layer Height

BL Depth [x1000 ft] THU 04/07 21Z(15mdt) 9hrFcst ETA



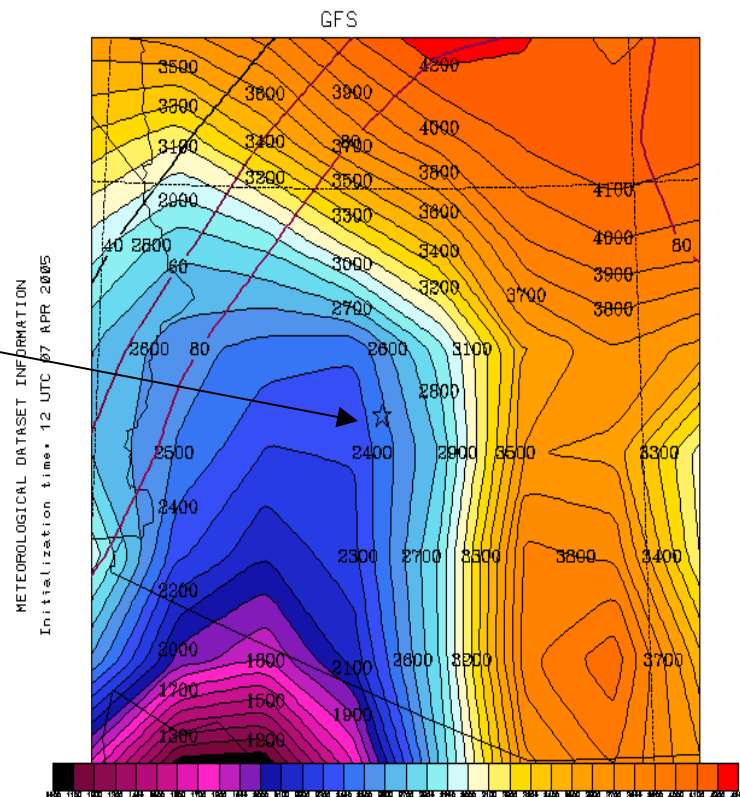
7845 Ft

2450
meters



NOAA Air Resources Laboratory

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AVERAGE TOTAL CLOUD COVER
PLANETARY BOUNDARY LAYER HEIGHT
TCLD (PCT), LVL= SFC , 21 UTC 07 APR 2005 (+ 09 H)
PBLH (M), LVL= SFC , 21 UTC 07 APR 2005 (+ 09 H)



Summary

- Check forecast weather
 - Sun
 - Cloud
 - Winds
 - Maximum temperature
 - Satellite images
- Check Blipmaps & Blipspots
 - Thermal strength
 - Top of Lift
 - Cumulus
 - Buoyancy/Shear
- Check Soundings
 - FSL Interactive
 - NOAA Ready
- Check Trends
 - High pressure building?
 - Dry air moving in?
- Watch the sky
 - Do conditions match the forecast?
 - Check temperatures